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ABSTRACT

This guide provides basic information on the Clean Water Act, watersheds, and testing for water quality, and presents four science lesson plans on water quality. Activities include: (1) "Introduction to Water Quality"; (2) "Chemical Water Quality Testing"; (3) "Biological Water Quality Testing"; and (4) "What Can We Do?" (YDS)

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An Educator's Guide to Water Quality

earth day network

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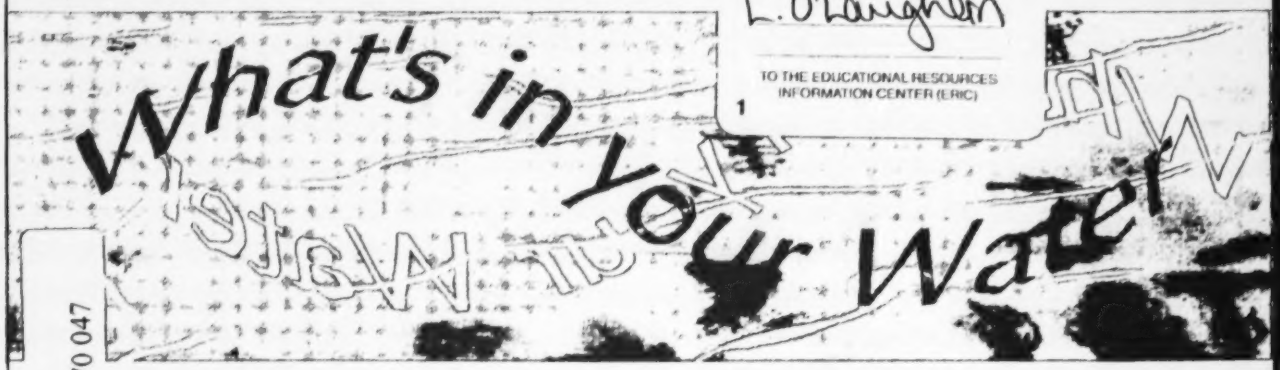
1



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Dear Educator,

This year on October 18, 2002, Earth Day Network will join with teachers, community groups, and millions of students across the country to observe the 30th anniversary of the Clean Water Act.

To help you and your students take part in this nationwide event and measure the health of your local water resources, we have produced a new teacher's guide called "What's in Your Water?" This guide provides basic information about water quality and lesson plans with hands-on activities for performing simple and fun water quality tests in lakes, streams, creeks, ponds, or other safe accessible water sites in your community.

You may either purchase an inexpensive test kit with materials for 50 tests through our website at www.earthday.net or create your own simplified version. Either way your students can report the results of their tests by entering their data on the national Clean Water Data Collection Site where they will be able to compare the health of their water with those from hundreds of sites around the nation. In addition, there are suggestions for how students can report their results to community leaders and elected local, state and federal officials.

Today, 32 years after the first Earth Day, Earth Day Network is an alliance of 5,700 organizations in 184 countries working to promote global environmental consciousness and a peaceful, just, and sustainable world. As one of the more than 95,000 educators in the United States who coordinates Earth Day events or activities, you are a vital part of the Earth Day movement. We value the work that you do and thank you for your ongoing participation and commitment to the Earth.

Please let me know what you think about this guide and your suggestions for our new program on sustainability. We invite you to check our website periodically to learn about our global campaigns, locate resources, and measure your Ecological Footprint.

Sincerely,

Kathleen Rogers

Kathleen Rogers
President, Earth Day Network

Four Lesson Plans
Grades 5-8

Introduction to Water Quality

Chemical Water Quality Testing

Biological Water Quality Testing

What Can We Do?

Topics Covered:

The Clean Water Act of 1972
How to Locate Your Watershed
How to Test for Water Quality
Pollutants and Human Activity
Point and Non-Point Pollution
How to Reduce and Prevent Non-Point Pollution
Community Action Opportunities

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2

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The Clean Water Act

More than 30 years ago, the United States faced a water quality crisis. Pollutants from human, animal, and industrial sources caused Ohio's Cuyahoga River to burst into flames; oil spills on both coasts posed threats to marine wildlife and human health. Lake Erie was declared dead. Both the Potomac River in Washington, D.C. and the Boston Harbor seemed more like cesspools than waterways. Public outrage at such environmental disasters brought clean water to the forefront of the civic agenda. Congress responded in 1972 by signing the Clean Water Act, formally known as the Federal Water Pollution Control Act.

The Clean Water Act seeks to "restore and maintain the chemical, physical, and biological integrity of the nation's water." Consequently, states adopted uniform minimum water quality standards, monitored by the then newly-created Environmental Protection Agency (EPA). Today, reduced toxic flows have lowered fish kills allowing lakes and rivers to revive. Municipal wastewater treatment plants, supported by billions of dollars in federal investments serve almost 190 million people, 50 million more than in the late 1960s.

The Clean Water Act guarantees us clean, safe water for drinking, fishing, and swimming. Nevertheless, it is important, to understand that 40% of our water sources still do not meet healthy standards.

Source: United States Public Interest Research Group, Clean Water Network

Watersheds

How to locate your watershed:

The EPA provides a useful site, where students can enter their home information, from zip code to tribal nation, locate and learn about their local watershed at: http://cfpub.epa.gov/surf /locate/index.cfm

A watershed is the region that draws water and snowmelt into bodies of water. Every waterway, whether a small tributary, stream, or lake, has its own associated watershed.
Watersheds can be large or small and can extend across county, state, and national boundaries.

In addition to acting as drainage basins, watersheds capture precipitation, filter, and store water. Within each watershed there is a diverse system of ecoregions, marine life, and air sheds. Everyone living and working within a watershed needs to cooperate to ensure healthy conditions because water moves downstream in a watershed. Any activity that negatively affects water quality will change the characteristics of the water downstream as well, and impact on the water quality of the body of water.

Simple choices in daily activities that can affect watershed health include: dumping used motor oil down a sewer; over-fertilizing lawns and gardens; applying sand and chemicals to driveways and sidewalks; removing vegetation such as plants, trees, and grasses along a riverbank; leaving pet waste on the ground; and poorly maintaining home septic systems. Communities as a whole can also affect the water quality of a watershed through land use decisions such as where to locate housing, shops, factories, parks, and farms. By analyzing a watershed's physical charact4ristics and land use patterns, students will understand how their watershed is changing and what they can do to protect it. Raising awareness by involving individuals and their communities creates a collaborative effort to protect home watershed areas. Students can play a powerful role in this process.

Source: Adapted with permission from Earth Force. For more information, see www.green.org

Testing for Water Quality

*Field Experience (with or without kit) **

Water quality testing determines whether water is safe for different types of use such as swimming, fishing, drinking, and irrigation. Knowledge of the water quality within your watershed provides understanding about human activities and our role in the ecological processes. Typically, tests for water quality identify several indicators that can be used to determine the health of a watershed. Key indicators include alkalinity, dissolved oxygen, nitrates, pH, temperature, and turbidity. A glossary of key terms follows:

Alkalinity measures the ability of the water to neutralize (or buffer) acids and keep the pH from changing. **Sources:** Rocks, soils, salts, plant activities, and certain wastewater discharges. **Effects and Hazards:** High water alkalinity causes higher algae and plant growth; while low alkalinity indicates that the water's ability to buffer acids is poor. If there are drastic changes in alkalinity, many chemical and biological processes will be affected.

Dissolved oxygen measures the presence of oxygen gas molecules in water. These oxygen molecules keep organisms living, sustain species reproduction, and support many chemical processes that occur in water. Water that maintains high dissolved oxygen levels is generally considered environmentally healthy; although saltwater, warm water, and water at high altitudes can contain less dissolved oxygen and still be part of a health-sustaining ecosystem. **Effects and Hazards:** Low dissolved oxygen levels stress fish and other aquatic organisms.

Nitrates are essential for plant growth, although too much nitrate may indicate a pollution problem. **Sources:** Soil, animal wastes, and decomposing plants; sewage, fertilizers, and animal waste. **Effects and Hazards:** High levels of nitrates affect dissolved oxygen levels and lead to excessive plant growth, affecting the types of plants and animals that can live in the water. Infant blood poisoning, cancer, and genetic changes have been attributed to high levels of nitrates.

pH measures the acidity of a solution as an "index" of the amount of hydrogen ions present in a substance and affects many chemical and biological processes. **Sources:** Acidity increases due to mine draining, industrial waste, and acid precipitation.

- pH is measured on a scale of 0-14, with a neutral pH at 7
- A pH less than 7 is an acid, with more hydrogen ions
- A pH greater than 7 is basic, and has more hydroxide ions
- Most natural water has a pH value between 5.0 and 8.5. Rainwater has a pH between 5.5 and 6.0. Salt water has a pH between 8.0 and 8.5
- Most aquatic animals prefer a range of 6.5 to 8.0
- All water with a pH of less than 5.0 or greater than 8.5 should be viewed as suspicious

Temperature measures the degree of heat in the water which affects the rate of many of the waterways' biological and chemical processes and the amount of dissolved oxygen. **Sources:** Air temperature, the amount of runoff, the temperature of water running into the waterway, amount of sunlight, and water cloudiness. **Effects and Hazards:** Temperature affects the rate of photosynthesis and decomposition in plants. High temperatures may be a sign of thermal pollution from industrial sites.

Turbidity is the clarity of the water. Clear water has a low turbidity while murky water has a high turbidity. **Sources:** Small particles suspended in water such as algae, clay, microorganisms, silt, organic chemicals, decaying vegetation, or chemical wastes. **Effects and Hazards:** Turbidity can interfere with the process of disinfecting water. Particles may absorb or bond with toxic substances and prevent their removal during treatment.

Adapted from:
http://www.beesinc.org/resource/currenha/watmonit.htm
http://wilkes.edu/~eqc/helpguide.htm

* Note: If you have purchased the NWMD kit, you can follow the instructions included with it.

Pollutants and Human Activities

There are many different sources of water pollution. Water quality changes quickly as water composition is altered by various ground surfaces over and under which it flows and combines with rock, minerals, other elements and numerous materials which are a direct result of human activities. The latter will be of particular importance to students as it relates to how their daily lives can affect our water sources.

Point and Non-point Source Pollution

Pollution that comes from a single, identifiable source, such as a factory or discharge from a sewage treatment plant, is called point source pollution. Once the source is identified it becomes easier to improve water quality. Non-point source (NPS) pollution is attributable to diverse sources. The EPA reports that NPS pollution is a leading cause of water quality problems. NPS is primarily caused by rainfall or snowmelt moving over and through the ground causing runoff to pick up and carry away natural and human-made pollutants. This runoff finally deposits the pollutants into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water.

Example Pollutants

- Excess fertilizers, herbicides, and insecticides from agriculture and residential areas
- Oil, grease, and toxic chemicals from urban runoff and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks
- Salt from irrigation practices and acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems

How to Reduce and Prevent Non-point Source Pollution

Some activities are federal responsibilities such as ensuring that federal lands are properly managed to reduce soil erosion. Some are state responsibilities: for example, developing legislation to govern mining and logging and to protect groundwater. Others are handled locally, through zoning and erosion control ordinances. As citizens, we play an important role by practicing conservation and by making it our personal business to properly dispose of home hazardous water, using non-polluting lawn and garden supplies, recycling plastics and other detrimental debris. Finally instilling an awareness which will engender careful and conscientious practices in our daily activities both personally and through our community programs does much to assist in controlling NPS pollution and will ultimately safeguard our watershed.

Source: Environmental Protection Agency (http://www.epa.gov/owow/nps/qa.html)

Preparation for Lesson Plans

You may purchase an inexpensive test kit with materials for 50 tests through our website at http://www.earthday.net/ goals/clean_water.stm or by calling 1-800-344-3100 ext. 7015. You may also create your own kit. Either way, your students can report the results of their tests by entering their data on the national Clean Water Data Collection Site. Registration should be done in advance, on the web page listed above, so that you can compare your results with those from thousands of sites around the country. If possible, plan ahead to arrange a field trip or determine an on-campus outdoors site in which to perform these water quality tests. If this is not possible, give yourself and your students at least one week to bring in samples from an appropriate source. These sources include lakes, streams, ponds, creeks, or ocean—not puddles, tap water, or storm drains.

Recommended Internet Resources can be found on our website at http://www.earthday.net/ goals/clean_water.stm.

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Lesson Plan 1: Introduction to Water Quality

OVERVIEW:	KEY ISSUES/ CONCEPTS
In this collaborative, hands-on activity students learn about clean water and how to test for it. Using historical information, scientific background, investigation and hands-on experimentation, students will learn about their role in the water cycle, and how human impacts can both positively and negatively affect water quality in local, regional, national and worldwide watersheds.	Water Quality Chemical Testing Biological Testing Relative Impacts SUBJECT AREAS Chemistry, Biology Environmental Studies History, Geography GRADE LEVEL : 5-8

Setting: Indoor
Class Size: 50 and under

Preparation: Register water testing site (if doing field water testing) on Year of Clean Water national water quality monitoring website: http://www.earthday.net/goals/clean_water.stm

Materials: Newspapers and magazines with articles relative to water quality, reference books, in-class Internet access if possible.

Time: 45 minutes to 1 hour

Objectives:

- Describe water, watersheds and the water cycle, human interactions and their effect on the water cycle
- Identify local watershed(s) using research skills through books, magazines and Internet
- Understand the importance of clean water in the historical context of the Clean Water Act

Activities:

1. **Discussion** (15 minutes) Use this time to introduce topics and discussion about water

   - What does water do for us?
   - Where does it come from?
   - What would happen if it were polluted? Define polluted.
   - Why is it important to have clean water? What is clean water?
   - Does our state or community have certain standards for water quality?

2. **Research** (20-25 minutes) Put students in groups of two and assign each group a question. Bring in newspapers, magazines with pertinent articles. Have students use Internet (see Recommended Internet Reources on our website, http://www.earthday.net/goals/clean_water.stm) encyclopedias, and other media to research water pollution. If possible, invite a local water expert to present information.

3. **Closure** (5 -10 minutes) Share information. Assign homework:

   - Have each pair create a hypothesis for lab for another class
   - Have each student bring in a jar and lid for taking samples

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Lesson Plan 2: Chemical Water Quality Testing

OVERVIEW:	KEY ISSUES/CONCEPTS:
This is a hands-on activity where students learn about key chemical indicators of water quality and about the health of their own watershed through field experience. Students collect water samples, analyze the quality of the collected water, and test their predictions, while also learning about how humans affect the water cycle.	Water Quality Chemical Testing Scientific Method SUBJECT AREAS: Chemistry, Biology, Environmental Studies, Earth Science GRADE LEVEL : 5-8

Setting: Indoor and outdoors
Class Size: 50 and under

Materials: Clean Water Testing Kits or thermometers, Secchi disk, pH strips, dissolved oxygen test tabs, glass jars to collect additional samples for biological testing during next class, samples of different types of water, some airtight, some not.

Time: 45 minutes- 1 hour (allow more time if testing outdoors)

Objectives:

- Determine what makes water of good or poor quality
- Discuss and define key indicators to water quality
- Gain scientific field experience while collecting water samples
- Use test to evaluate and determine the quality of water sampled

Activities:

1. **Discussion** (5-10 minutes) Students share results from research. Discuss testing process. Information can be found in the kit directions and lab rules.

2. **Water testing** (25 minutes) If testing outdoors, assign pairs to a specific spot to sample. Try to test in many different areas to ensure diverse results. If possible, schedule as a field trip to increase available time and have students sample several different areas and compare the results. **Have students take additional samples in jars for biological water quality testing during next class period.**

If testing indoors, students should have brought in samples. Make sure you have some pond water or ocean water samples they can compare with their tap water.

3. **Closure** (5 minutes) Assign homework:

- Students document their lab findings either in narrative format or as a laboratory write-up
- Create predictions for biological water testing. Have students research the organisms and species that live or have lived in their watershed

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Lesson Plan 3: Biological Water Quality Testing

OVERVIEW:	KEY ISSUES/CONCEPTS:
This is a hands-on activity where students learn about key biological indicators of water quality and about the health of their own watershed through field experience. Students collect water samples, analyze the quality of the collected water and test their predictions, while also learning about how humans affect the waer cycle.	Biological Testing Water Quality SUBJECT AREAS: Biology, Earth Science, Environmental Studies GRADE LEVEL : 5-8

Setting: Indoor lab activity
Class Size: 50 and under

Materials: Hand-held magnifying glasses, lab notebooks, eyedroppers, microscopes, slides/cover slips, samples from previous testing of different types of water, dichotomous key or pictures of common organisms found in like water sources.

Time: 45 minutes- 1 hour

Objectives:

- Apply knowledge from chemical testing to create predictions of the impact of chemical water health on biological water quality
- Relate biological water health to learned historical impacts of poor water quality

Activities:

1. **Discussion** (5-10 minutes) Students share predictions and findings from research. Discuss observation process. Distribute hand-held magnifying glass, instruct on use of microscopes if necessary (i.e., lenses, cover slip fragility, etc.).

2. **Biological water testing** (25 minutes)

- Have students examine water with untutored eye, noting presence of plants or visible aquatic organisms, marking observations in lab book
- Examine under hand-held magnifying glass, marking observations in lab book
- Using an eyedropper, students put a few drops of water on a slide, topping with a cover slip. Examine under microscope, noting observations in lab book

If students brought in their own samples, make sure you have some pond water or ocean water samples for making comparisons.

3. **Closure** (5 minutes) Assign homework:

- Students document their lab findings either in narrative format or laboratory write-up
- Students should think of ways they can improve the health of their water
- Encourage research about what others have done to improve the quality of water in their communities

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Lesson Plan 4: What Can We Do?

OVERVIEW:	KEY ISSUES/CONCEPTS:
In this follow-up exercise students work together to interpret the results of water quality testing. They learn about the sources and effects of pollutants on water health and identify how they personally affect water quality and how they can work to improve it	Water Quality Pollutants Personal Impact SUBJECT AREAS: Environmental Studies. Social Studies, Language Arts, Art GRADE LEVEL : 5-8

Setting: Indoor
Class Size: 50 and under

Materials: Art materials, researching materials, reports on water quality from your local water company, local environmental groups, and/or State Environmental Protection Department.

Time: 45 minutes

Objectives:

- Describe pollutants, their sources and their effects on biological and chemical health of water
- Generate an overall idea of the health of local watersheds, using results, consensus-building and brainstorming skill
- Identify how students affect water quality through daily interactions affecting the water cycle
- Identify opportunities for civic action on a personal, local, national and international level

Activities:

1. **Discussion** (5-10 minutes) Compile all hypotheses and results as a class and brainstorm about what the results mean. Translate into real world language.

2. **Assignments** (20 minutes) Suggested projects for service learning (in groups of 3-4):

   - Field trip to water plants and reservoirs, especially if outdoors testing was not possible
   - Write a persuasive piece about why it is important to test water (in form of letter or report)
   - Turn lab reports into art and/or presentation projects, posters, oral and/or written reports, displays on the status of your local watershed, incorporating student results and what students think needs to be done to improve local water quality

3. **Closure** (5 minutes) Continue classroom assignments as homework (essay, artwork, report).

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Suggestions for Civic Action

Get the Word Out!
Students share their knowledge of local water quality

Not all members of your community have the opportunity to participate directly in water quality testing. In fact, they may not even be aware of the potential threats to their watershed's health. Take advantage of student knowledge to educate the community.

Possible activities include:

- **Media outreach:** Have students write letters to the editor regarding the health of their water shed, including simple suggestions for improvement. Or, working in groups, have students write and distribute a press release to local media in order to encourage reporters to cover water quality and your class' activities.

- **Community art exhibit:** Find a community sponsor (library, grocery store, shopping mall, etc.) where students can hang their awareness-building artwork in a high traffic area. Include projects that highlight not only the problems, but also possible solutions.

- **Political action:** Your students may not be old enough to vote, but that doesn't mean they can't have a voice. Have students meet with government officials or attend town hall meetings and raise the issue of water quality. Or take advantage of campaign season to highlight a candidate's position on watershed protection and other environmental issues.

Community Water Testing Night
How clean is our water? What can we do?

This activity will not only raise awareness, but will also give community members the opportunity to participate in testing similar to what the students did. Invite parents, media (students might draft a media advisory) politicians, water experts, etc.

- Include a water quality testing station so visitors can test water samples themselves. Identify the source on a map
- Students can present reports, show posters and art projects
- Encourage citizens to take action similar to the suggestions under "Get the Word Out!"
- If local politicians attend your event, try to organize a follow-up forum with city or county leadership, including possible introduction of legislation to protect the local watershed

Storm Drain Stenciling

If you determine trash from storm drains to be a possible pollutant in your community, this is a great project for students. Students mark drains with stencils that advertise that all dumped materials flow into the local watershed. The storm drains provide a long-term reminder that everyone is responsible for protecting their watershed's health. Post flyers in the stenciled neighborhoods, allowing students to share their findings with the community. This also provides a long-term reminder for everyone. The flyer may also be a good place to advertise your Community Water Testing Night.

For more information: http://www.earthwater-stencils.com/foredu.html

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What's in Your Water?

Introduction to Water Quality

Chemical Water Quality Testing

Biological Water Quality Testing

What Can We Do?

Join us in Celebrating the Year of Clean water!

News from Earthday Network

We are developing a year-round educational program, focused on sustainability with opportunities for teaching the skills of civic action and environmental citizenship. This guide marks the first step in this exciting new direction.

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